The Illinois Chemistry Teacher

A Journal

The Illinois Association of Chemistry Teachers

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Chemical Sterilization of Water

BY HOWARD W. ADAMS

PROFFESSOR OF CHEMISTRY, ILLINOIS STATE NORMAL UNIVERSITY

Probably sixty percent of the population of the United States are enjoying the health protection which comes from the use of sterilized water supplies. Assuming an average per capita daily consumption of 100 gallons, it follows that there must be the collection, filtering, after the softening, the sterilization and distribution through an intricate system of underground conduits at a fairly constant pressure, of approximately seven and one-third billion gallons daily. Here is a triumph of science and engineering of which the consuming public is scarcely aware, and whose attention is called to the quality of the product only on those rare occasions when an unusual taste or odor is found in the supply. Its bacterial quality is such that over long periods of time not a single organism may be found in a ten cubic centimeter portion. This service is rendered at a cost in the neighborhood of one penny per day per person.

The wholesale sterilization of water supplies in the U. S. A. began about 1910. Nowhere is the efficiency of the process more evident than in the decline of deaths from typhoid fever which is so generally a water borne disease. In 1910 the rate per 100,000 of poulation in the United States was 22.8, in 1920, 7.6, and in 1930, 5([1]).

In terms of human lives saved, these figures mean a yearly conservation of 21,894 while the number who have yearly escaped the disease is probably five times as great. That this saving in human life and suffering can largely be attributed to sterilization is shown in the case of the city of Milwaukee ([2]). In 1916 the sterilization of lake water with chlorine was discontinued for a period of eight hours. There resulted 50,000 or 60,000 cases of gastro-intestinal trouble and within the next few weeks 400 or 500 cases of typhoid fever with 40 to 50 deaths. Again, the city of Olean, N. Y., ([3]) having a population of 21,600 had an outbreak of the disease in 1928, traceable to faulty operation of the city's water sterilization equipment, in which there were 248 cases and 25 deaths. The city was empowered to issue $425,000 in bonds to cover its liability. Merchants estimated a loss of $200,000 in business while $125,000 was expended on improvements in the waterworks, making the total water bill for the city $750,000, which is a percapita cost of $34.80.

In our own state where 52% of the inhabitants use chlorinated water, it is clearly apparent that regions of high population have low rates, while rural areas have high rates.

Typhoid Fever in Illinois, 1931 ([4])

				Rates	
	Population	Cases	Deaths	Case	Death
Northern Sec. 33 counties	5,648,608	223	29	3.9	0.5
Central Sec. 35 counties	1,150,547	158	25	13.7	2.2
Southern Sec. 34 counties	985,485	423	73	42.8	7.4
STATE TOTAL	7,784,650	804	127	10.3	1.6

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THE
ILLINOIS CHEMISTRY TEACHER
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Normal, Illinois

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SINK OR SWIM

Is the Illinois Chemistry Teacher to continue? Do we science teachers know that support—yes ACTIVE SUPPORT —is absolutely necessary if this work of our Association is to carry on? I believe we, as most others, mentally endorse work we consider desirable but do little about it unless we know the work will fail. So I believe it is quite timely to point out what must be done to successfully carry out the work of the ILLINOIS CHEMISTRY TEACHER in bringing you the best material of our programs. I do this with the utmost confidence that if you feel the work is worthwhile you will give it your active support. It is not enough to be passively concerned. **We must do.** Success depends upon the cooperation of all.

One of the greatest helps that can be given is to convince advertisers who are using this Journal that their products receive the consideration they deserve. Let them know you appreciate their advertising for they are performing a real service for our Association. Mention this Journal when you write them or talk with their representatives. Furthermore, if you could convince other possible advertisers whose representatives call upon you to solicit your business (whether books, chemical, or apparatus) that support of your Journal would be appreciated—in terms of dollars and cents, then the future success of this Journal is assured.

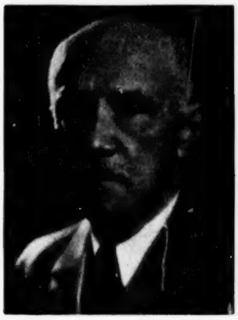
Another help is to become an active member of the Illinois Association of Chemistry Teachers. The mailing costs of the Journal are all financed from the membership fees.

Furthermore, we would appreciate hearing from you as to what you think about our common problem and also what you expect to do. We certainly do appreciate the support that has already been tendered and especially the fine spirit in which it has been given.

The Editor.

Professor Hessler Made President of the James Millikin University

The Illinois Chemistry Teacher extends congratulations to President John C. Hessler of the James Millikin University, formerly Professor of Chemistry at Knox College, upon his advancement to the new position. As for James Millikin University, we believe the choice of President Hessler is a step forward inasmuch as he not only has a most careful training in the field of science which will make for progress of the institution but also is quite versatile in other fields. He proved to be a man both of action and of ability, as a teacher, author, and research worker, and has been so recognized in Who's Who in America for a number of years.



Prof. J. C. Hessler

President Hessler is not new to the alumni of the school as he was Professor of Chemistry there from 1907-1920 and from 1917-1920 was also Dean. Previously he was an instructor in the University of Chicago. During 1920-21 he was Assistant Research Director at Mellon Institute of Industrial Research at Pittsburgh, Penn. Since then he has been Professor of Chemistry at Knox College until elected by the Board of of Managers of the Decatur College of the James Millikin University as President of that institution.

As a member of the Illinois Association of Chemistry Teachers he has been a consistent worker and a strong supporter of the Association. His major interest having been in the field of Chemistry will insure the teachers of this science a cordial welcome at James Millikin University. .. The chemistry teachers of this state will join with the alumni, faculty, and students of the institution in wishing him well. Editor.

Teaching Ideals to Pupils

UNIVERSITY OF ILLINOIS DR. R. M. PARR URBANA, ILLINOIS

It is generally understood that laboratory experience imparts certain skills together with training in mental activity associated with those skills. Values secured by high school pupils in chemistry frequently are limited to the ability to follow instructions from a laboratory exercise book and to use apparatus designed for use in demonstration of some theorm or fact stated in a text-book. These products of laboratory activity are not to be minimized, but the instructor will find other factors in the teaching of the course which at present remain untouched. I speak of the possibility of developing ideals in the midst of the daily routine of the laboratory and classroom.

Flint, in his book on "Philosophy of History" says that "it is in types, or **ideals**, that we must look for the **chief impelling powers** of **history.**" Our high school pupils are at an impressionable age and since, as they grow older they will soon be in positions to influence the trends of civic movements, it behooves the teachers in science, as well as teachers of history and of other subjects, to find means and occasions to develop ideals of the higher type. Perhaps no field of teaching brings teacher and pupil within so close an association as is found to exist in science classes and here are formed many opportunities for the development of ideals,—those "master keys" of learning which make possible the "carry over" of things learned by the pupil in the classroom, into his outside life activities.

Standards of excellence in daily work in chemistry, when once idealized, will give a tendency toward achievment of

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Problem Solving Technique in Laboratory Work

H. WALDO HORRABIN

WESTERN ILLINOIS STATE TEACHERS COLLEGE MACOMB, ILLINOIS

In seeking to improve my laboratory work in H. S. Chemistry I have adapted a method which has demonstrated its superiority to the traditional method. The basic feature of this technique is the problem solving approach to laboratory work. I have used this method over a period of three years in various types of subject matter. A testing program has confirmed my belief that it is an efficient teaching device.

The gist of the method is that to a very great extent the pupils devise their own experiments. The class meets before a laboratory period and with the guidance of the teacher, devises an experimental procedure. This is done as follows: the general problem is stated and a method of problem solving attack is worked out. The teacher calls upon the students for ideas, which are listed on the board. The students will then point out the advantages or disadvantages which each separate suggestion calls for, and using their previously learned facts, agree upon a worthy procedure. This has the advantage of encouraging the student to think both constructively and critically. When the class and the instructor (who is always the final judge) agree upon a method of procedure, each student copies the steps from the board and then proceeds into the laboratory to carry out the agreed procedure. The experiment is then a uniform one, made up of the composite of the ideas of the class. The student will know more about the experiment than if it were merely an assigned one from the manual, since he actually devised it himself. He will write the experiment up in his own words and in a style that would suggest to the reader that the experiment was actually original with the student.

I have found from my experience with this method that the apparent advantages are (1) clear, scientific, constructive and critical thinking; (2) a greater premium and need for remembering previously learned facts; (3) better knowledge of the experiment at hand, since it actually is the student's experiment; (4) greater interest in the experiment and its success since the student feels that he actually devised it; (5) a more efficient learning process as actually demonstrated by immediate and delayed recall tests; (6) a complete escape from the evils of the old "cook book system" we have all seen so often.

I know that many of you have done something of this in your own teaching, and furthermore I do not claim the plan is entirely new, since considerable work has been done in this line by Ralph Horton at Columbia University. (Outcomes of Individual Laboratory Work in Chemistry—Columbia University Contributions to Education). We have had the following criticisms made of our traditional formal laboratory procedure:

1. It tends to develop the idea of following a recipe.
2. It makes no allowance for development of individual initiative.
3. It tends to develop mental laziness in place of mental activity.

Since one of the greatest aims in teaching science is the development of scientific procedure in thinking, there is ample reason for seeking a substitute for the style of teaching which contains the evils just enumerated. In seeking to remedy this situation, we have hit upon the "Research Lab. Method", which we are recommending to you for a trial.

The ideal method of presenting laboratory material—that of having each student work out the laboratory solution for his own problems— is impossible as a general laboratory procedure for classes of the usual size and ability. Realizing this, our method has been abridged to meet practical needs. In practice the plan is merely this: the class working with the teacher devise an experiment and then go into the laboratory and work out the problem. It may readily be seen that such a procedure will create a great deal of interest in the pupil, since he is doing an experiment that he has helped to

(Continued next page)

devise, that the old set routine of following a manual outline would utterly fail to elicit. Where we have tried it, the plan has been successful for the most part and has created a great deal of interest as well as furthering the fundamental aims of teaching Chemistry. Each pupil becomes in part, a **miniature research worker** with a problem to solve.

The following table shows results obtained from a testing program in attempting to evaluate the two types of laboratory work. Students were shifted from method to method in order to overcome individual differences and likewise make it possible to study their reactions to the two methods.

CLASS A
23 Students

Unit Taught	*X	Y	Z
Water & Hydrogen peroxide	86	87	79
Gas laws	79	78	75
Sulfur	92	90	81
Solutions	89	89	84

CLASS B
19 Students

Halogens	91.2	92	79
Acid, Bases, Salts	89	91	80
Alkali Metals	78	81	69
Ionization	84	84	80
Fuels, Combustion	78	82	69

CLASS C
15 Students

Nitrogen	79	81	68
Alkali Earth	76	80	71
Colloids	75	77	60
Iron & Steel	81	80	72

CLASS D
16 Students

Carbon	90	91	79
Oxygen	88	84	79
Hydrogen	78	81	72

TRADITIONAL METHOD

Unit Taught	*X	Y	Z

*Column X—Immediate Recall
Column Y—Recitation
Column Z—Delayed Recall — 4 weeks later

CLASS A
20 Students

Water & Hydrogen peroxide	82	80	68
Gas laws	78	77	75
Sulfur	90	87	74
Solutions	86	87	78.8

CLASS B
22 Students

Halogens	81	86	63.2
Acids, Bases, Salts	72	76	60
Alkali Metals	69	71	61.8
Ionization	80	79	76.5
Fuels, Combustion	74	76	62

CLASS C
17 Students

Nitrogen	71	77	62
Alkali Earth	68	70	62
Colloids	70	72	60
Iron & Steel	78	76	63

CLASS D
13 Students

Carbon	84	84	73
Oxygen	88	82	68
Hydrogen	77	80	70

Student Questionnaire

	Prob. Solv. Technique	Tradi. Method
Which method is more interesting?	129	21
Which method gives you the clearest understanding of the experiment?	118	32
Which method enables you to remember results better?	121	29

GUIDE FOR TEACHER

1. Discontinue use of the laboratory manual.

2. Require pupils to devise their own experiments.

3. Make a home assignment one day per week for the day preceding the laboratory day (or days).

4. This home assignment is to be in the nature of a perplexity arising from the chemistry topic of the week. Each student should follow the following procedure: (1) Make a definite question; (2) make a guess as to the answer (hypothesis); (3) devise an experiment to test the validity of this hypothesis; and (4) make a sketch of the apparatus set-up to do this experiment. This outline should be placed in the pupil's note book.*1

5. In class discussion, the standard procedure will be decided upon.

6. The students record the facts, make a conclusion as to the truth or incorrectness of their hypothesis, and decide whether the problem is satisfactorily solved or needs further experiment.

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A Unit Organization For Teaching High School Chemistry

J. STERLING MARSHALL HIGH SCHOOL CICERO, ILLINOIS
L. T. LUCAS

(Continued from May Issue)

Many people consider it not possible to build a library but it is not so difficult as it may seem. However, that is one detail that must grow gradually and slowly in most schools. One bright spot is the fact that the library can be built up without a cent of expense to the school and at an actual saving to the parents of the pupils, if the school does not furnish free textbooks. One example of what can be done along this line is illustrated by the method in which a history teacher built up a very good classroom library during the past few years. In this particular case the pupils are not required to buy text-books but are required to pay a stipulated fee for materials for the year and the fee is considerably less than a textbook would cost. The money thus collected each year has been used to purchase text and supplementary books to be kept and used in the classroom.

Some of the handicaps to be overcome in this case are: lack of sufficient books in the classroom; lack of space in which to keep books, notebooks, and supplies; one classroom and one laboratory to be used by three classes each two periods which means that the rooms are used every period during the day.

Our school has been forced to economize rigidly resulting in the reduction of the library budget to a minimum. Under such circumstances it is not likely that an individual teacher will be allowed money with which to purchase books for the use of his classes exclusively. The situation is aggravated by the fact that the students are supplied with free textbooks. Each student registering in chemistry is required to deposit two dollars for a laboratory and breakage fee and to buy a laboratory manual. Since the experiment was started several days after the opening of school the above mentioned matters had already been taken care of. It is not likely that permission could have been obtained to assess those students further in order to have money with which to buy books for the classroom. However, each student had his own textbook and a few copies of a discarded high school text and a few copies of a discarded junior college textbook were discovered in the school and salvaged for use in the classroom. The librarians were persuaded to allow some of the least used chemistry books from the library to be taken to the classroom for use

The forty minute periods are largely compensated for by the fact that there are double laboratory periods twice a a week. However, the laboratory does not make an ideal study room. The forty minute period on the other days is almost too short for the best work after time is taken out for distributing materials at the beginning of the period and collecting them at the end of the period.

Billet[9] has found that most schools using the unit organization use a six step teaching procedure. These steps are: exploration, presentation, assimilation, organization, recitation, and testing for mastery. Some teachers also add re-teaching and re-testing. The exploratory period is to determine which students are to be excused from part or all of the work on the unit because they already have a mastery of part or all of the unit. This step has been omitted in the present experiment, because the conditions are not adaptable to this procedure. The presentation period is a brief preview of the unit by the teacher and usually requires one period or less. The assimilative period is the time during which the pupils study the unit by carrying out the activities assigned in the guide sheet. This period is usually from two to six weeks depending upon the difficulty of the unit and the ability of the pupils. As practiced at Morton this is a supervised study period in which all the activities are carried on by the pupils in the classroom under the direct supervision of the teacher. The

pupils are very seldom given assignments to do at home and when such assignments are given they are usually for memorization of facts which they should keep in mind. At the beginning of each period monitors distribute the pupil's notebooks, which the pupils are required to leave in the classroom at all times. At the same time the librarian issues the books that each student requires for his study during that period. All questions on the guide sheets are answered on the work sheets which are kept with the guide sheets and other materials in the notebooks. At the end of the period the monitors and librarian are responsible for seeing that all notebooks and books are in the locker which is used for that purpose.

As some may question this procedure I shall briefly give my reasons for requiring all notebooks to be left in the classroom and for having most of the work done there. It has been my conviction for some time that one of the greatest reason for students failing to have their lesson and for their failure to retain material is the lack of a suitable place and an atmosphere for study. Moreover, when a student meets with a difficult situation during his study it is probably best that the difficulty be cleared up at that particular time. A student may lose his interest in a subject and may fall behind in it because he is not able to understand a particular part of a lesson and that handicaps him for the next lesson. Thus he may become discouraged and will become more indolent as the difficulties pile up. I also believe that there are few places that are as ideal for study as in the classroom in the presence of a teacher. Two reasons for not allowing the notebooks to be taken from the classroom are, first, that there is no necessity for them to be taken out and, second, if all written work is done in the classroom the tendency to copy instead of studying is discouraged to a great extent.

The organization period is the time during which the material gathered is organized into a coherent and logical argument and is in outline form. This period is usually rather short. The recitation period is for the purpose of having the students present the unit to the class, for clarifying the vague points, and for correcting any incorrect conceptions. This period usually takes from one to three class hours. The purposes of the three remaining steps are probably evident and nothing need be said here concerning the time each requires. At Morton very little has been done in re-teaching and retesting except for the class as a whole. If the majority of the class has failed to show a mastery of the unit, the entire class is required to do further work in it. One reason for this proceedure is the desirability of keeping the class fairly well together.

Probably the ideal practice is to allow each student to proceed at his own speed. As soon as each completely masters one unit, he should be allowed to go on with the next one. However, this is not always feasible in actual practice and in this case it is found to be impractical. For that reason additional activities and assignments can be made for the more rapid students to work out while the slower students are completing the unit.

As to the success of the present experiment, observations so far lead me to the conclusion that there is some value in this organization of chemistry. In the first place there have been no failures in the class although the instructor has held the pupils to a higher standard than have the pupils in the other chemistry classes. This fact might be explained by the teacher's zeal for the unit organization or for his interest in the success of the experiment if it were not for the fact that three other teachers are in charge of some of the other classes being used as a comparison. Also it seems that the present class is doing much better work than previous classes have.

There have been only two withdrawals from the class for any reason since the beginning of school. The class started with an enrollment of thirty-two, and thirty of the original members are still in the class. At the same time an average of three to four students withdrew from each of the other classes, because of failure or other reasons. One of the withdrawals from the class using the unit organization, which class here-

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Crystal Growing

DUPO HIGH SCHOOL WILLIS T. MAAS DUPO, ILLINOIS

The interest shown by teachers and students who have seen the crystals presented at the meeting of the Junior Academy of Science held at Decatur, Illinois, May 4, 1934, has led the writer to record the method used in growing them, for the benefit of others who are interested.

The interest of the writer in crystal growing was aroused by articles in the Journal of Chemical Education. (namely)

The Preparation and Preservation of Large Crystals of Chrome Alum. Leonard J. Fliender. J. Chem. Ed. Vol. IX. 1453-4. Aug. 1932.

Some Experiments With Crystals. Charles E. Stone. J. Chem. Ed. Vol. IX. 1107-9. June 1932.

The crystals shown were as follows: ferrous ammonium sulfate, monoclinic, blue-green; aluminum potassium sulfate, octahedral, colorless; copper ammonium sulfate, rhombic, blue; Rochelle Salts, trimetric prisms, colorless; copper sulfate, triclinic, blue; potassium dichromate, monocl., red; citric acid, rhombic, colorless; nickel ammonium sulfate, green crystals, with twelve faces, six of which are the reverse of the other six, with the pairs opposite to each other on the crystal.

The variety of colors displayed by crystal substances, the different shapes exhibited, and the physical property of efflorescence combine to make crystals an interesting subject for experiment and study. This applies not only to the teacher but also to any able and interested students who may find the time for such work. A few directions dealing with crystal growing follows:

Prepare a saturated solution of the salt selected by adding pure crystals to room temperature distilled water until some of the crystals remain undissolved after frequent stirring over a period of hours or days. Filter the solution into a clean crystallizing dish, enamel pan, or beaker and set aside in a place free from dust.

A thoroughly saturated solution will hasten the formation of "seed" crystals. After several days a considerable crop of seed crystals should have formed on the bottom of the pan. When these seed crystals are large enough to observe that they have perfect geometric shape they may be placed into another pan and then covered with new filtered saturated solution. Then this pan containing the one or more seed crystals should be set aside in a place as dust free as possible and having a uniform temperature.

These tiny seed crystals should grow larger depending upon the evaporation of the water from the solution. Other factors that determine the rate of evaporation and the rate of growth of the crystals are the temperature and movements of the air over the pans. Also in the writer's experience when the humidity of the atmosphere is high and the pressure low, such as precedes rainy weather, the crystals may experience misfortune and dissolve. If such weather can be predicted by reading the barometer or watching reports, crystals that are not efflorescent may be taken from the solution and exposed to air until an area of high pressure and dry air is in the community, which is favorable for rapid evaporation. Then the crystals should be replaced. Copper sulfate crystals may thus be removed, but it is not wise to remove those composed of chrome alum.

It is best to watch the growth of seed crystals daily. Every other day may be satisfactory as Monday, Wednesday, and Friday. Two crystals in a dish may grow so rapidly as to touch each other. This may cause them to grow together or spoil the geometric shape of each. Sometimes a dish containing a large seed crystal may become contaminated with hundreds of tiny crystals. The large crystal should be removed and placed into another dish and freshly filtered solution should be added to cover it. If the filtered solution that is added is not saturated the seed crystal will be dissolved to make the solution saturated. This retards progress. If small bud crystals attach themselves to the main crystal they may be scraped off. A growing

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PROGRAM

Illinois Association of Chemistry Teachers

Time - November 23 **Place - Urbana, Illinois**

Physics Building, University of Illinois

Morning Session, 9:00 A. M.

Chairman — W. Glen Tilbury, Urbana High School

Secretary — M. E. Woodworth, Pittsfield High School

Air Conditioning — Professor M. K. Fahnestock, University of Illinois

Vacuum Tubes (demonstration) -- Professor H. J. Reich, University of Illinois

Use of Films in Teaching the Physical Sciences — Russell T. Gregg, University High School, Urbana.

Noon, 12:00 o'clock

Lunch for Members of Illinois Association of Chemistry Teachers
Southern Tea Room, 624 E. Green Street
(One block west of physics building)

Talk — Sweets from Artichokes -- Dr. Duane T. Englis, University of Illinois.

Afternoon Session, 1:45 P. M. (Physics and Chemistry)

Chairman — Allen R. Moore, J. Sterling Morton High School

The Teaching of Physical Science — Professor Wilbur L. Beauchamp

Chemistry Section, 2:30 P. M.

Chairman — J. C. Chiddix, Normal Community High School

Helping the Student Who Is to Take College Chemistry — Professor B. S. Hopkins, University of Illinois

Vitamins in Relation to Health — Dr. R. M. Parr, University of Illinois

Comparative Tests in Chemistry — Carl E. Ekblad, Moline Senior High School

Chemistry Museum Displays — Walter E. Hauswald, Beardstown High School

(Note: Reservations for the luncheon should be sent to Mr. Glen Tilbury, Urbana High School, Urbana, Illinois. The cost is 50 cents.)

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100 PERCENT MEMBERSHIP

Why not be 100 percent organized and working as a unit for the advancement of chemistry teaching and for the welfare of the profession in this state. Isolated individual effort accomplishes little whereas the same effort directed through an organization accomplishes much. The Illinois Association of Chemistry Teachers is working for your interests and those of your students. It provides helpful programs for you, gives financial support to the Illinois Junior Academy of Science, and helps to finance the Illinois Chemistry Teacher.

You may send your membership fee (50 cents) to:

Mr. H. L. Slichenmyer, Seretary-Treasurer, Bloomington High School, Bloomington, Illinois.

Mr. Slichenmyer has your membership card ready for you. Why not send the one dollar for two years? It would be less trouble to mail and also would simplify the matter of records.

Work for 100 percent membership

Chemical Sterilization of Water

(Continued from page one)

It is to be observed that 12.7% of the population, that of the 34 counties, had 52.6% of the cases and 57.5% of the deaths from the disease in the state.

In 1896 G. W. Fuller ([5]) applied chloride of lime to the raw water supplying the city of Louisville, Kentucky. A similar treatment was given the water supply of Maidstone, England, in 1897, while similar experiments were started five years later in Belgium. The animals in the Union Stock Yards, Chicago, were given water from Bubbly Creek in 1908 containing the chloride. Ten years later the city began the chlorination of the public supply. In the last two decades the process has been perfected and has been extended so rapidly that the world traveller need never be far beyond its protective influence.

At the present time liquid chlorine is almost universally used. The liquid gasifiies and then is carried into the water. The fundamental chemical reaction is believed to be that in which hypochlorous acid is produced.

$$Cl_2 + H_2O = HOCl + HCl$$

The hypochlorous acid is believed to be the sterilizing agent. In addition to this function the chlorine may chlorinate such materials as amino acids, unsaturated compounds and phenol bodies, if present in the water, while oxidizable substances as aldehydes, ferrous and manganese salts and hydrogen sulfide may be acted upon by the hypochlorous acid. These reactions necessitate the increase in the dosage in order to insure a high degree of sterilization. This may mean the application of two or more parts per million in order to obtain a residual amount of 0.2 or 0.3 parts per million. With chlorine selling at four cents pound a dosage of 5 parts per million represents a cost of but $1.70 per million gallons, which means a per capita cost of about six cents yearly. In addition to its bactericidal value, chlorination prevents algae growths on filters and clarifying units at the water plant, thus increasing their usefulness.

The Problem of Tastes and Odors

Chlorination of water containing organic materials frequently produces derivatives having marked and disagreeable tastes and odors. These products are causes of frequent complaint on the part of the consumers of water and are a matter of grave concern to the plant superintendent. Tastes in chlorine treated water are classified as cholrinous, i. e., produced by an excess of free chlorine, and chlorophenolic, those resulting from the chlorination of phenolic bodies. The latter tastes and odors are much more pronounced and are, therefore, a more frequent cause of trouble. Thus, chlorinated otho hydroxy benzaldehyde can be detected to the extent of one part ([6]) to 1000 million parts of water, while the product arising from ordinary phenol is detectable in one part to 100,000 million. Women, in general, can detect by taste chlorine derivatives in higher dilution than men. The chlorophenolic tastes in the water of the south side of the city of Chicago are attributed to phenolic waste poured into the lake at South Chicago and adjacent points. Phenols in stored water may also arise from decomposition of organic materials.

Taste preventions by use of Chloramines. In order to prevent the action of chlorine on organic substances present in the water, the practice has arisen of feeding both chlorine and ammonia to the water thus producing chloramines which are odorless, tasteless, and nontoxic to human beings, but more effective as germicides than chlorine, although somewhat slower in action.

The reactions involved are as follows:

(1) $Cl_2 + H_2O = HOCl + HCl$

(2) $NH_3 + H_2CO_3 = NH_4HCO_3$

(3) $HOCl + NH_4HCO_3 = NH_2Cl + 2\,H_2O + CO_2$

(4) $2\,HOCl + NH_4HCO_3 = NHCl_2 + 3\,H_2O + CO_2$

(5) $3\,HOCl + NH_4HCO_3 = HCl_3 + 4\,H_2O + CO_2$

According to Chapin ([7]), the predominating reaction is determined by the hydrogen ion concentration of the solution. Thus at a pH of 8.5 (Fig. 1) the product is 100% monochloramine, (reaction (3)) while at 4.4 it is entirely dichloramine (reaction (4)). Below 4.4, seldom met in water practice, reaction (5) sets in.

Fig. 1 ([8]) Relation of pH to Chloramine Formation.

The formation of the mono- and di-chloramines through the use of ammonia saves the chlorine used in the treatment from being consumed by the organic matter, thereby preventing undesirable tastes and odors, and permits the carrying of a desirable chlorine residual of 0.2 or 0.3 parts per million for a longer time in the distributing system. In practice the ammonia dose is about one-half the chlorine. Recently the use of ammonium sulfate instead of ammonia has been adopted at certain plants.

Taste and odor removal by active carbon. Charcoal has long been supposed to be highly efficacious when used as a filtering agent for the improvement of water. Ordinary, or non-active carbon has been found to have a phenol absorptive capacity of but one per cent of that of highly active carbon. For water treatment the carbon is finely powdered and of great absorptive surface. Garner, McKie and Knight ([9]) report that one cubic foot of active carbon, weighing 10 pounds, has a surface area of 3,000,000 square feet. It is fed into the water by means of a dry feed mechanism at the rate of about five parts per million parts of water or 42 pounds per million gallons at a cost of $2.10. The carbon is applied, of course, ahead of the filters. Such material furnishes inexpensive insurance against undesirable taste and odors, while the application is so elastic that seasonal trouble may be taken care of. Such treatment is also of high value because the quality of the water holds the confidence of the public. Sterilization, accompanied by undesirable tastes and odors, in a considerable measure defeats its own purpose, but with the undesirable qualities removed it becomes a great human blessing.

Thus, through the combined efforts of science and engineering, one of the essentials of human existence, water, is practically no longer a vehicle for the spread of contagious diseases. The value of this in promoting public health is immeasurable.

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A Unit Organization for Teaching High School Chemistry

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after will be referred to as the unit class, withdrew at the beginning of the semester, before the unit organization had been given a good trial. The other student was confined to the hospital and his home during the entire first semester. No new members were admitted to the class. Some explanation of the fact that the original class is almost intact might be discovered other than the type of work the class is doing and for this reason the fact will not be stressed too much.

Another discovery was made upon examining the attendance records of all chemistry classes at Morton for the first semester. Using the average number of absences per pupil in the classes as a basis of comparison, it was found that there is almost three and a half times as many absences in all chemistry classes as there are in the unit class.

As yet there is no other basis than the above on which to compare the unit class with the others, but at the end of the year we hope to give all classes a good standardized test which will provide comparison. Only the results obtained from those classes in the same intelligence group will be used to determine the effectiveness of the unit organization.

In conclusion I would like to stress the fact that this experiment is still in its early stages and I do not claim that the unit organization which I have is superior to any other organization, nor that my organization is the ultimate course for high school chemistry. I will be satisfied to let future results decide some of those questions and in the meantime I believe that I have a more logical arrangement for high school chemistry than that presented by most modern high school chemistry texts.

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Teaching Ideals to Pupils

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better work in other fields. There is much greater satisfaction in achievement through adherence to ideals than that derived from high grades alone.

Honesty and integrity may be taught in the science laborator,—for instance, in cases where one pupil copies from others the pupil can be shown that the reactions which he actually observes and records are of real significance in his education, whereas copied reports of reactions that were not observed are unscientific, unethical, and only lead to slovenly habits and to a lost sense of his own mental integrity.

A question which the young teacher frequently asks is "What shall we do when our experiments fail to work in order that we may keep the confidence of our pupils in ourselves and in the text-book?" Here the instructor's own integrity seems to be at stake, but he may arise to the occasion and explain that for perfect results in this type of experiment many factors must be under control while in the experiment that failed the attempt was made to control only two or three of those factors. The scientists who established the law had broad experience and accurately regulated aparatus, and it is through the use of such equipment and the correct interpretation of results made by trained minds that the scientific principles and facts given in text-books have been established. By this mode of teaching, ideals of accuracy, of carefully collected data, and of scientific method of interpretation, are stressed; and, incidentally, a situation that could easily have left an inferior teacher in a state of embarrasment has been skillfully turned into an occasion for inspirational teaching.

In each worth while laboratory exercise there is opportunity to develop self-reliance, thoughtful attitude, keen observation and, usually, a process of reasoning. If the pupil is brought to realize that he can establish these methods of gaining knowledge as a part of his mental equipment that will constantly be useful to him, in other words, if he idealizes the scientific method for securing information and solving problems, the educational values of the exercise will be greatly enhanced.

Short informal talks on community affairs may be introduced, and these may be introduced, and these may include topics of health, the city water system, clean streets, pure food, etc. Alert teachers are finding time for all of this and more. Perhaps some of them will favor us with concrete examples of their own experiences in this line.

Crystal Growing

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crystal should be kept covered with solution to the depth of one half inch.

The crystals may be grown by letting them rest on the bottom of the pan, or they may be suspended on a string. New seed crystals may be formed on a suspended string.

During a period of five months, a high school student, member of the class of the writer, grew a copper sulfate crystal weighing 190 grams. All of the crystals shown at the Junior Academy of Science meeting were grown by the same high school boy. He also grew eighteen chrome alum crystals averaging the size of walnuts.

Other salts that may be used for crystal growing are: sodium chloride, barium chloride, copper chloride, lead nitrate, sodium nitrate, ferric ammonium sulfate, potassium chromate, potassium sulfate, potassium hydrogen sulfate, magnesium sulfate, zinc sulfate, and many others depending upon the crystals at hand. Copper chloride, which dissolves cellulose, must be filtered through asbestos.

Chrome alum crystals effloresce rapidly in air. They may be preserved by immersing them in a saturated solution of potassium aluminum sulfate until a layer of this salt about one-eighth inch in thickness has been deposited.

Growing crystals is really not so difficult. It requires time, patience, persistence, punctuality, a little skill, and the materials with which to work. Let it be a challenge to many high school students to grow some crystals and bring them to the Junior Academy Meeting in 1935.

The Book Shelf

THIS CHANGING WORLD

BY S. R. POWERS, E. F. NEUNER, AND H. B. BRUNER

Published by Ginn & Company, New York

This Changing World, which is the second in a series of three books written for science in the Junior High School, has several features that should be noted by chemistry teachers as desirable for inclusion in their special field.

Aside from presenting the material in harmony with the principles of modern psychology through giving an interesting preview, raising challenging questions and natural problems which are staged in a stimulating setting, etc., this book as well as its predecessor, The World Around Us written by the same authors. definitely carries the student toward specific objectives of recognized value in life. In the main the material does lead consistently toward three objectives which the authors set forth in the preface as being—

1. To develop an understanding of, together with an ability and desire to use, those scientific attainments that may function in intellectual experiences most common to everybody.
2. To develop some understanding of, together with an ability and desire to use, some of the methods by means of which scientific attainments have been achieved.
3. To engender the scientific attitude of respect for truth and for scientific methods.

It seems that the chemistry course, particularly for the high school, also should be centered about objectives, including the ones listed above, that are of real value in the life of the average individual. It is an easily observed fact that present chemistry texts for high school students are not written from this point of view and are of no great value in planning a course centered about life values. However the present lack of suitable texts should not prevent the teacher who is concerned for the preparation of his students for life through a living science from adapting the course to their needs. Certainly a sterotyped college preparation course is not a prime objective, for less than half our chemistry students go to college and less than 10 per cent of these take college chemistry. Preparation for highly specialized work in this field belongs to the college and university, not to the high school. It seems that chemistry teachers may well profit by noting the presentation of scientific principles and concepts by Powers, Neuner, and Bruner in This Changing World as an illustration of some of the possibilities in working toward objectives of real value in life. Editor.

EXPERIMENTS AND PROBLEMS FOR COLLEGE CHEMISTRY

BY J. E. BELCHER AND J. C. COLBERT

Published by D. Appleton-Century Co., New York

In Experiments and Problems for College Chemistry, a first year college laboratory work book, an attempt is made to relate the theory of the text more closely with the laboratory work by including many leading questions along with the experiments. The questions are of the type that lead the student on to an understanding of the principles of chemistry involved in the experiments.

With each experiment a short discussion is given to make clear what the experiment is about and to give a better background for understanding it. Many problems are given similar to those presented in the experiment. Blanks are provided in which to write the answers to the questions. An outline of the work is also included as well as helps in problem solving and equation writing. The high school teacher will find in it some very good supplementary material for the better students. Editor.

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Problem Solving Technique in Laboratory Work
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7. Practice at all times—in demonstrations, class questioning, and all class work—the exercise of this method of thinking or checking up on thought.

8. Let the class see that thinking is fundamental in life, is really simple, and that it is within the capacity of everyone to improve to some extent, and at least get the habit of criticizing his own thinking after it has occured—by a scientific method.

9. Steps in a scientific procedure:
   - A. What is the precise question.
   - B. What are the possible answers?
   - C. What evidence exists for this or that answer?
   - D. Can I prove it?
   - E. Does this answer fit the question I started out to solve?

Note: The main purpose of the teacher is to act as a guide for the discussion and as a referee in controversial points. By skillful questioning and suggestion, the teacher can get the class to devise any desired experiment that would ordinarily be given in the manual.

*1. Do not expect the students' answer to the problem to be accurate and workable. What we wish in this is proof of the students' thinking. In a large percent of cases, the suggestions of the students are both wise and worthy.

*2. By guiding the discussion, the teacher can make students devise any desired experiment, the main difference being that the experiment is theirs rather than that of the author of the manual.

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